

Aletha de Witt The tenth IVS General Meeting Longyearbyen, Norway 3-9 June 2018



Co-authors



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Overview: Improving the S/X CRF



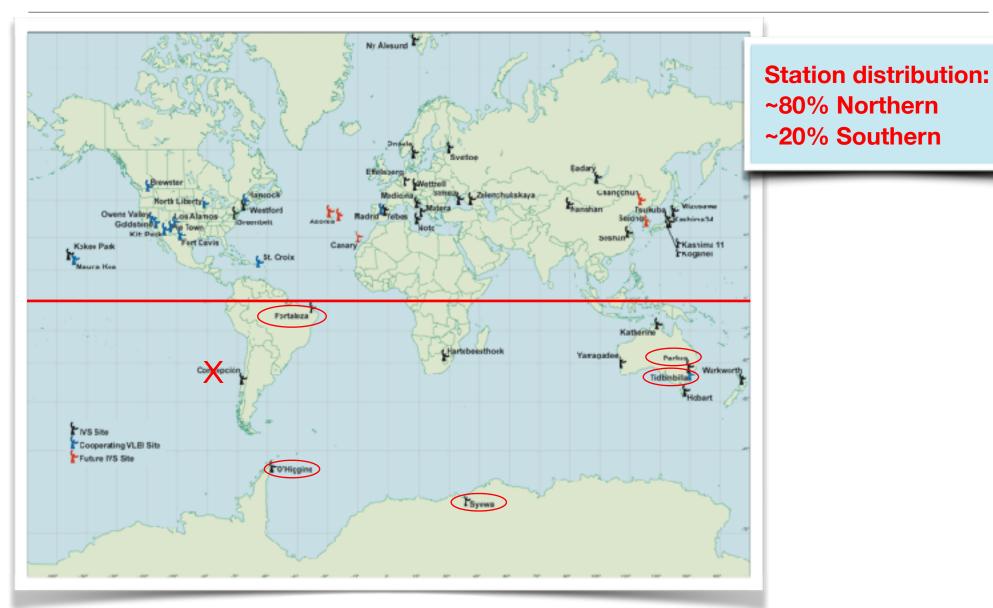
- History: Catalogs of compact radio sources (incl. ICRF-2) are generally weaker in the south by factors of 2 or more in both density and precision.
 (e.g. Ma et al., ICRF-2, 2009).
- The current S/X frame has deficiencies by factors of 2-3 in the south.
 (e.g. Charlot et al., ICRF-3, IVS GM, 05 June 2018).

We have started a collaboration to correct this:

- Increase data rate by factor of 4 or more, from 256 Mbps to 1 2 Gbps
- Increase in sensitivity, detection of weaker sources
- Scheduling optimised for astrometry & imaging instead of geodesy
- Improve precision by a factor of 2.5
- Mapping & monitoring of source structure
- Expand source list by a factor of 2, improve spatial coverage
- Improve overlap with K-band, Ka-band & Gaia optical CRF

Network Stations: North vs South





Observations: North vs South





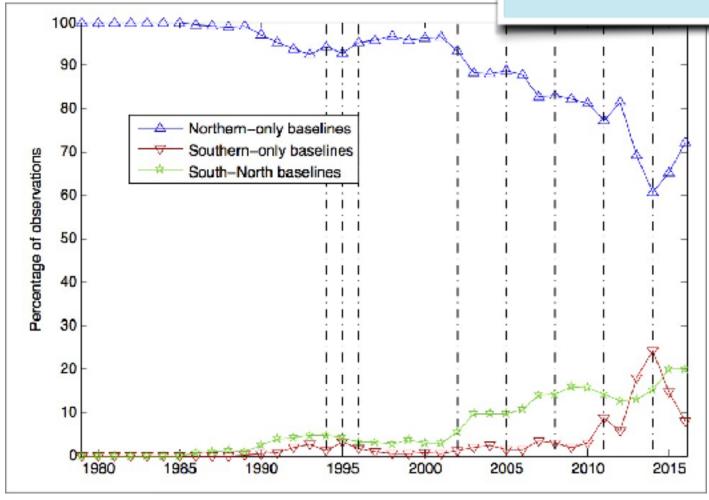
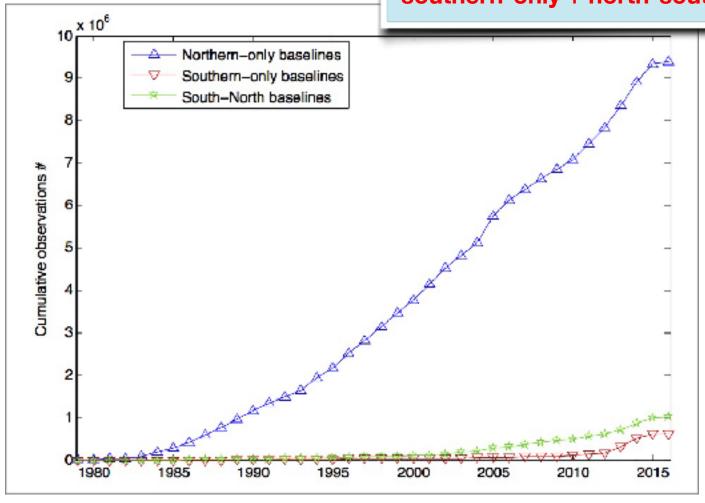


Image Credit: Ma et al., IVS General Meeting, 2016

Observations: North vs South



Growth of observations: southern-only + north-south baselines ~15% of total



North-South CRF Statistics

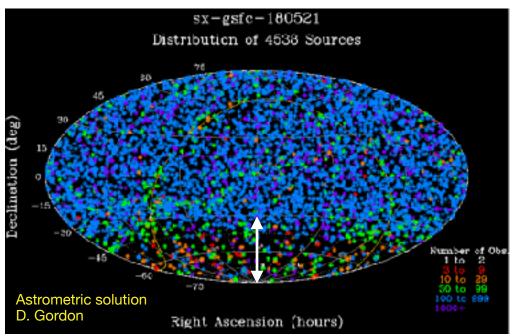


Number of Sessions

sx-gsfc-180521 Distribution of 4530 Sources Declination Astrometric solution D. Gordon

Right Ascension (hours)

Number of Observations



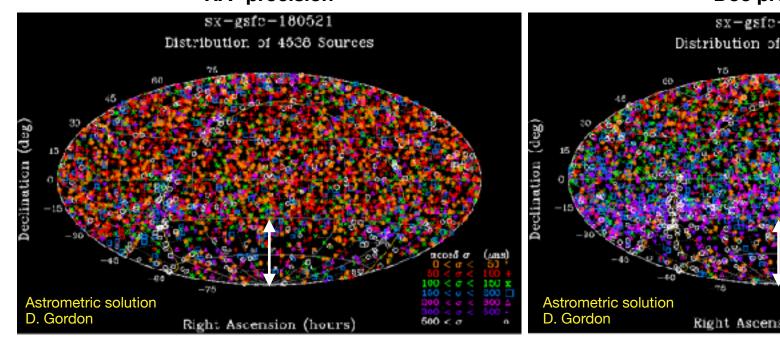
Number of sources factor of 2 less in far-south (<-30°S) vs. far-north (>+30°N) Average number of sessions per sources is larger in far-south Average number of observations per source is factor of 2 less in far-south

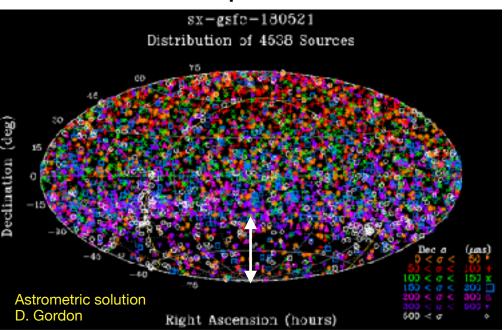
- Current S/X shows significant improvement over ICRF2
- We need more sources in the South (< -30° South)
- We need to improve the spatial coverage in the South

North-South CRF Statistics







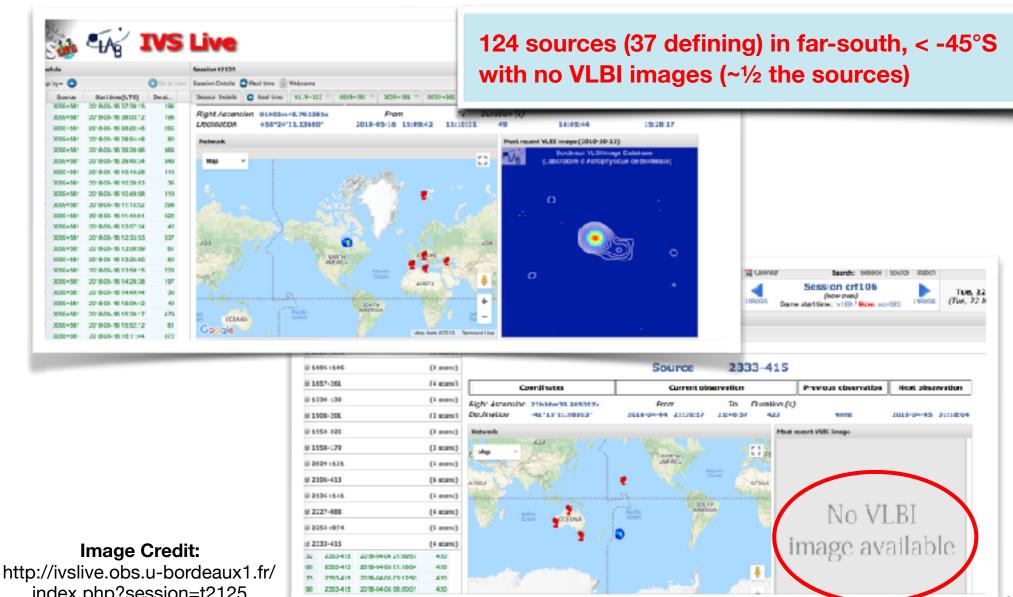


Median σ -RA factor of 1.5 weaker in far-south (<-30°S) vs. far-north (>+30°N) Median σ -Dec factor of 2.7 weaker in far-south

- Declinations are consistently worse than RA even at equator
- Need more southern baselines
- Need more north-south baselines

Imaging North vs. South





index.php?session=t2125



Increase data rate of southern observing programmes by factor of 4 or more:

- IVS astrometric programmes, CRF and CRDS, at 128/256 Mbps
- Increase data rate to 1 2 Gbps
- Increase sensitivity by factor of 2 or more
- Detect weaker sources down to ~350 mJy or less
- Scheduling will become more efficient
 - more sources to choose from
 - shorter scan times,
 - more scans/sources or more sources/schedule

IVS-CRDS (CRDS):

Celestial Reference Frame Deep South

IVS-CRF (CRF):

Celestial Reference Frame

AUS-AST (AUA):

AUSTRAL, Australia (AuScope) and New Zealand geodetic VLBI network

Progress to date:

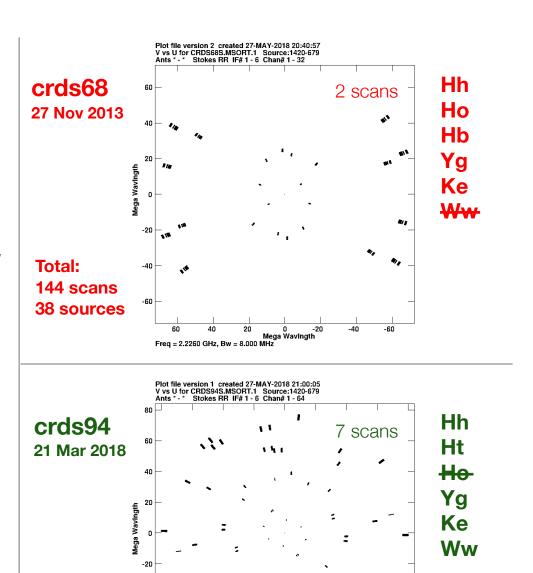
- 1 Gbps observing mode tested and implemented for IVS-CRF & IVS-CRDS
 - 1 Gbps from 24 Jan 2018, crds93
 - 1 Gbps narrow-band mode tested on 4 April 2018, crf106
- Additional 1 Gbps AUS-AST sessions at 1/month from Aug 2017
 - SOuthern Astrometry Project (SOAP, http://astrogeo.org/soap/)
 - tested 1 Gbps mode that is used also for CRDS sessions

Scheduling optimised for astrometry & imaging instead of geodesy:

- Use full network when possible for every scan.
- Around 3-8 scans/source spread evenly over HA range.
- Include tropospheric calibrators, also used as ties and for amplitude calibration.
- Schedule a campaign not an experiment!

Progress to date:

- Optimised scheduling for all IVS-CRDS sessions since crds93.
- VieVS group (Vienna) testing new scheduling software for astrometry & imaging (M. Schartner).



0 -2 Mega Wavingth

Freq = 2.2000 GHz, Bw = 16.000 MHz

Total:

304 scans

51 sources



Improve precision by a factor of 2.5:

 Only ICRF2 DEFINING sources observed in IVS-CRF & IVS-CRDS sessions.

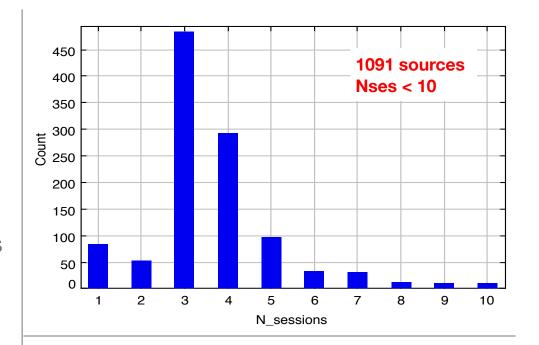
Re-observe ALL southern sources in current S/X CRF.

Improve source position accuracy in both coordinates.

From 1344 sources > -15°S we have 1091 sources with Nses < 10 We will prioritise 216 sources with flux density > 350 mJy.

Progress to date:

Non-defining sources added to IVS,
 CRDS and CRF since Dec 2018.



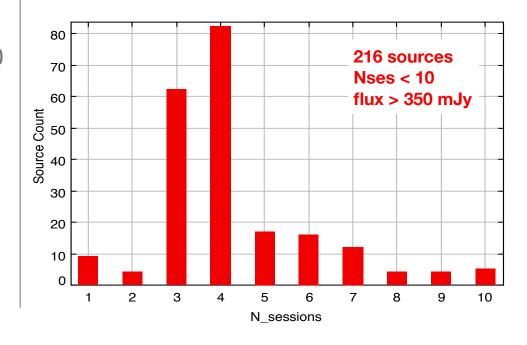
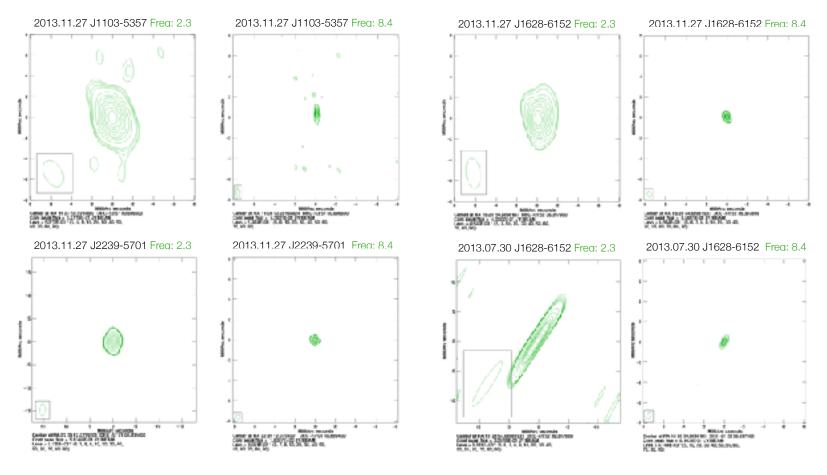






Image sources in S/X-band to quantify non-pointlike structure:



Focus on 124 sources in far-south with NO VLBI images. Completed imaging of crds66/68, 2013 (e.g. Basu et al. 2016).

Currently working on imaging of first 1 Gbps session, crds94 (Mar 2018).



Improve the far-south by a factor of 2 in density:

- Expand source list in the south, specifically in the far-south <-45°S.
- Improve spatial coverage in the south, specifically <-30°S.
- Improve overlap with K- and Ka-band frames & Gaia optical frame.

Progress to date:

- K- and Ka-band sources added to IVS-CRF & IVS-CRDS sessions since Dec 2018
 - We have ~80 K- and Ka-band sources not in current S/X frame at <-15°S.
 - From these we ~20 sources with flux density > 350 mJy at S/X-band.
- Additional 1 Gbps IVS-AUA sessions at 1/month from Aug 2017 SOAP
 - Follow-up to LBA Calibrator Survey (LCS, Petrov et al., 2011) done at X-band.
 - Improve positions of all known VLBI sources <-30°S by factor of 5 (0.3 mas),
 - Derive images at S- and X-band and determine jet directions.
 - SOAP Includes all sources (215) brighter than 250 mJy and < -45°S.
 - Priority is ~1/2 of the target sources that have a counterpart with Gaia.
 - Fifteen 24-hour SOAP experiments pool of candidate CRF sources!



Summary: Improving the S/X CRF

Goal: To improve the S/X-band frame in the south, by at least a factor of 2 in density and
 2.5 in precision, to be about as good as the north.

Roadmap:

- Increase data rate of southern IVS sessions (CRDS, CRF, AUA) to 1 Gbps.
- Optimise the scheduling of these sessions for astrometry & imaging vs. geodesy.
- Increase the number of well observed sources (Nses > 10) in the south.
- Increase the number of south-south but also north-south baseline observations.
- Image sources to quantify non-pointlike structure and measure jet directions.
- Expand the southern source list and improve spatial coverage.
- Get the far south precision about as good as the north.

Initial Steps are Succeeding:

- All IVS southern astrometric sessions now at 1 Gbps; IVS-AUA, CRDS and CRF.
- Non-defining sources in current S/X frame added to IVS-CRDS and CRF source list
- SOAP sessions started 2017 to re-observe LCS sources.
- LCS providing a pool of candidate CRF sources at S/X-band.



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Image credit: Ani Vermeulen, NASSP student 2014